इंटरनेट मानक

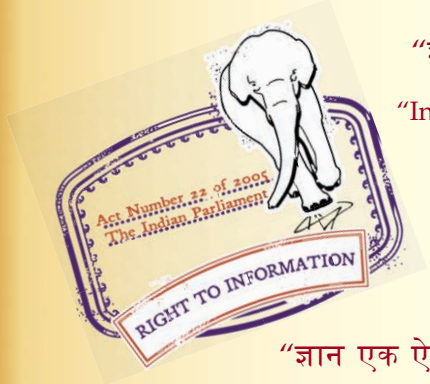
Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 9001-3 (1978): Guidance for environmental testing, Part 3: Change of temperature [LITD 1: Environmental Testing Procedure]



"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

BLANK PAGE

PROTECTED BY COPYRIGHT

IS : 9001 (Part III) - 1978
(Reaffirmed 2004)

Indian Standard

GUIDANCE FOR ENVIRONMENTAL TESTING

PART III CHANGE OF TEMPERATURE

UDC 621·38·038 : 620·193

© *Copyright* 1978

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Price Rs 5.00 Gr 3

September 1978

Indian Standard

GUIDANCE FOR ENVIRONMENTAL TESTING

PART III CHANGE OF TEMPERATURE

Environmental Testing Procedures Sectional Committee, LTDC 2

Chairman	*Representing*
BRIG D. SWAROOP	Instrumentation Ltd, Kota
Members	
SHRI H. R. BAPU SEETHARAM	Bharat Electronics Ltd, Bangalore
SHRI P. S. K. PRASAD (*Alternate*)	
DR A. S. BHADURI	National Test House, Calcutta
SHRI B. P. GHOSH (*Alternate*)	
BRIG N. DAYAL	Ministry of Defence (DGI)
SHRI G. R. GHOSH (*Alternate*)	
DIRECTOR STANDARDS (S & T)	Research, Designs & Standards Organization (Ministry of Railways), Lucknow
JOINT DIRECTOR STANDARDS (S & T)-I (*Alternate*)	
GENERAL SECRETARY	Society of Environmental Engineers, Bangalore
SHRI T. G. SRINIVASAN (*Alternate*)	
SHRI GHASITA SINGH	Central Electronics Engineering Research Institute (CSIR), Pilani
SHRI J. G. JAIN	Radio Electronic & Television Manufacturers' Association, Bombay
CENTRAL STANDARDIZATION OFFICER (*Alternate*)	
SHRI JOHN FRANCIS	Posts and Telegraphs Board, New Delhi
SHRI S. P. KULKARNI	Philips India Limited, Bombay
DR P. K. DUTTA (*Alternate*)	
SHRI V. A. MURARI	Lucas-TVS Ltd, Madras
SHRI B. K. BANERJEE (*Alternate*)	
SHRI D. V. PETKAR	Bhabha Atomic Research Centre, Trombay, Bombay
SHRI C. V. RAGHURAMAN	National Radio & Electronics Co Ltd, Bombay
SHRI K. RAMAN	Directorate General of Observatories (Ministry of Tourism & Civil Aviation), New Delhi
SHRI P. SANDELL	All India Instrument Manufactures' & Dealers' Association, Bombay
SHRI H. C. VERMA (*Alternate*)	
DR Y. V. SOMAYAJULU	National Physical Laboratory (CSIR), New Delhi
SHRI P. SURYANARAYANA (*Alternate*)	

(*Continued on page* 2)

© *Copyright* 1978
INDIAN STANDARDS INSTITUTION
This publication is protected under the *Indian Copyright Act* (XIV of 1957) and reproduction in whole or in part by any means except with written permission of the publisher shall be deemed to be an infringement of copyright under the said Act.

(*Continued from page* 1)

Members	*Representing*
SHRI T. V. A. SUBRAMANIAN	Electronics Corporation of India Ltd, Hyderabad
SHRI G. C. SAXENA (*Alternate*)	
SHRI D. SUBRAMANYAN	Indian Telephone Industries Ltd, Bangalore
SHRI A. SATHYANARAYANA (*Alternate*)	
SHRI K. N. TIWARI	Ministry of Defence (R & D)
SHRI P. K. SHUKLA (*Alternate*)	
SHRI N. SRINIVASAN, Director (Electronics) (*Secretary*)	Director General, ISI (*Ex-officio Member*)

Indian Standard

GUIDANCE FOR ENVIRONMENTAL TESTING

PART III CHANGE OF TEMPERATURE

0. FOREWORD

0.1 This Indian Standard (Part III) was adopted by the Indian Standards Institution on 3 April 1978, after the draft finalized by the Environmental Testing Procedures Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard shall be read in conjunction with IS : 9000 (Part XIV)-1978*.

0.3 This standard is based on IEC Publication 68-2-33 (1971) 'Basic environmental testing procedures, Part 2 Tests, Guidance on change of temperature tests', issued by the International Electrotechnical Commission.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

---

1. SCOPE

1.1 This standard (Part III) gives guidance to designers and testing personnel on the specification and use of change of temperature tests.

2. OBJECT

2.1 A change of temperature test is intended to determine the effect on the item of a change of temperature or a succession of changes of temperature.

It is not intended to show effects which are due only to high or low temperature. For these effects, dry heat test or cold test should be used.

---

*Basic environmental testing procedures for electronic and electrical items: Part XIV Change of temperature.

†Rules for rounding off numerical values (*revised*).

The effect of such tests is determined by the following:

a) Values of high and low conditioning temperature between which the change is to be effected;

b) The conditioning times for which the test item is kept at these temperatures;

c) The rate of change between these temperatures;

d) The number of cycles of conditioning; and

e) The amount of heat transfer into or from the item.

3. FIELD CONDITIONS OF CHANGING TEMPERATURE

3.1 In electronic equipment and components, only gradual changes of temperature usually occur. Parts inside an equipment will undergo slower changes of temperature than those on an external surface of the equipment when it is not switched on.

3.1.1 Rapid changes of temperature may be expected under the following conditions:

a) When equipment is transported from warm indoor environments into cold open air conditions or *vice versa*;

b) When equipment is suddenly cooled by rainfall or immersion in cold water;

c) In externally mounted airborne equipment; or

d) Under certain conditions of transportation and storage.

3.1.2 Components will undergo stresses due to changing temperature when high temperature gradients build up in an equipment after switching on; for example, in the neighbourhood of high wattage resistors, radiation may cause rise of surface temperature in neighbouring components while other portions are still cool.

3.1.3 Artificially cooled components may be subjected to rapid temperature changes when the cooling system is switched on.

3.1.4 Rapid changes of temperature in components may also be induced during manufacturing processes of equipment.

3.1.5 The number and amplitude of temperature changes, and the time interval between them, are important.

3.1.6 When a transfer time of 2 to 3 minutes is applied, the magnitude of thermal stresses experienced by the item will be less for very small items than for large ones. The thermal stresses, however, will bear a relationship to that which would be experienced by such an item when it was transported within a few minutes from an atmosphere at one extreme of temperature to one at the other extreme.

3.1.7 The effects on components and equipment of temperature rise and temperature fall may be different. Dew or frost appearing on components or equipment may cause additional stresses and, where these additional stresses are not desired, humidity should be suitably controlled to minimize these effects.

4. BASIC PHILOSOPHY

4.1 Design of Change of Temperature Tests — The change of temperature tests, as described in Sections 1, 2 and 3 of IS : 9000 (Part XIV)-1978*, comprise alternate periods at a high and at a low temperature with well defined transitions from one temperature to the other. The conditioning run from room temperature to the first conditioning temperature, then to the second conditioning temperature, and back to room temperature, is called one test cycle.

4.1.1 Test parameters are as follows:

a) Room temperature,

b) High temperature,

c) Low temperature,

d) Duration of exposure,

e) Interval between exposure to the two extremes of temperature or rate of change of temperature, and

f) Number of test cycles.

4.1.1.1 The high and low temperatures are understood to be ambient temperatures which will be reached by most items with a certain time-lag.

4.1.1.2 Only in exceptional cases may they be specified outside the normal storage or operating temperature range of the object under test.

4.1.1.3 The test is accelerated because the number of severe changes of temperature in a given period is greater than that which will occur under field conditions.

4.2 Purpose and Choice of Tests — A change of temperature test is not intended to simulate field conditions exactly. The purpose of a change of temperature test is to stress item in order to determine whether they have been properly designed and manufactured.

*Basic environmental testing procedures for electronic and electrical items: Part XIV Change of temperature.

4.2.1 Change of temperature testing is recommended in the following cases:

a) Evaluation of electrical performance during a change of temperature as described in Section 2 of IS : 9000 (Part XIV)-1978*.

b) Evaluation of mechanical performance during a change of temperature as described in Section 2 of IS : 9000 (Part XIV)-1978*.

c) Evaluation of electrical performance after a specified number of rapid changes of temperature as described in Section 1 or Section 3 of IS : 9000 (Part XIV)-1978*.

d) Evaluation of the suitability of mechanical components, and of materials and combinations of materials to withstand rapid changes of temperature as described in Section 1 or Section 3 of IS : 9000 (Part XIV)-1978*.

e) Evaluation of the suitability of construction of components to withstand artificial stressing, as described in Section 1 or Section 3 of IS : 9000 (Part XIV)-1978*.

4.2.2 The change of temperature tests specified in IS : 9000 (Part XIV)-1978* is not intended to evaluate the difference in material constants or electrical performance when operating under temperature stability at the two extremes of temperature.

4.3 Choice of Duration of Exposure — The duration of exposure should be related in such a way to the thermal time constant of the items (or of their critical parts) that they would reach the approximate ambient temperature of the space of the bath. It is, therefore, important to know the temperature time constant of the item. As the thermal time constant of the outside and inside parts of large items (equipment) may differ considerably from each other, it is preferable to take into consideration the thermal time constant of the innermost or most critical part.

4.3.1 The time constant depends upon the nature and movement of the surrounding medium [air in tests described in Sections 1 and 2 of IS : 9000 (Part XIV)-1978*, the relevant liquid, such as water in test described in Section 3 of IS : 9000 (Part XIV)-1978*], and it is desirable, therefore, to determine experimentally the time constant in the actual ambient conditions of test. When choosing the duration of the exposure, the following should be considered (*see* Fig. 1):

$$\text{if } t_1 \geqslant 5\,\tau \text{ then } d < 0{\cdot}01\,D$$

$$\text{and if } t_1 \geqslant 2{\cdot}5\,\tau \text{ and } < 5\,\tau \text{ then } d < 0{\cdot}01\,D$$

*Basic environmental testing procedures for electronic and electrical items: Part XIV Change of temperature.

where

t_1 = duration of the exposure;

τ = temperature time constant of the item;

d = difference between the temperatures of the test medium and the item; and

D = difference between the hot and cold conditioning temperatures $|T_A| - |T_B|$

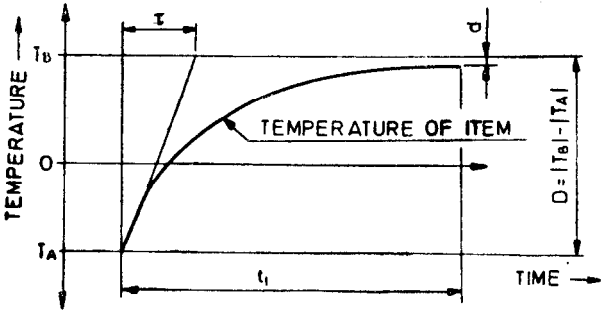


FIG. 1 CURVE OF TEMPERATURE *versus* EXPOSURE DURATION

4.4 Choice of Duration of Change-Over Time

4.4.1 *Choice of Duration of Temperature Change* — If, in the case of two-chamber method, in consequence of the large size of the items the change-over cannot be made in 2 to 3 minutes, the change-over time may be increased without an appreciable influence on the test results as follows:

$$t_2 \leqslant 0{\cdot}05\,\tau$$

where

t_2 = duration of the change-over time, and

τ = thermal time constant of the item.

4.4.2 *Choice of Rate of Change of Temperature* — The rates of change of temperature given in test of Section 2 of IS : 9000 (Part XIV)-1978* apply to the cases mentioned in 3. However, for large stationary equipments, tests of IS : 9000 (Part XIV)-1978* may be applied to simulate slower temperature changes, for example, those connected with diurnal variations. Such changes are normally considerably slower than 1°C/min. In such cases, test of Section 2 of IS : 9000 (Part XIV)-1978* may be applied with lower severities.

*Basic environmental testing procedures for electronic and electrical items: Part XIV Change of temperature.

4.5 Applicability Limits of Change of Temperature Tests

4.5.1 Inside an item, the rate of change of temperature depends on the heat conduction of its materials, on the spatial distribution of its heat capacity and on its dimensions.

4.5.1.1 The change of temperature at a point on the surface of an item follows approximately an exponential law. Inside large items, the superposition of such alternate exponential rises and decreases may lead to periodic and approximately sinusoidal changes of temperature with much lower amplitudes than the applied temperature swing.

4.5.2 The mechanism of heat transfer between the test item and the conditioning medium in the chamber or bath should be taken into account. Moving liquid leads to very high rates of change of temperature on the surface of the items and still air to very low rates.

4.5.3 The two-bath method with water as a conditioning medium as described in Section 3 of IS : 9000 (Part XIV)-1978* should be restricted to items which are either sealed or by their nature insensitive to water, as their performance and properties may deteriorate by immersion. In particular cases, such as, with items sensitive to water, other test liquids may be required. The characteristics of heat transfer of such liquids which may differ from those of water, have to be taken into account.

5. REPRODUCIBILITY OF CHANGE OF TEMPERATURE TESTS

5.1 Influence by the Conditioning Procedure — The reproducibility of change of temperature tests depends on the accuracy with which the test parameters, referred to in **4.1.1**, are maintained.

5.1.1 Variations in the following test perameters have important effects on reproducibility:

a) Rate of change of temperature of the surrounding medium.

b) Upper and lower temperatures.

c) Heat transfer mechanisms (by convection, thermal radiation and thermal conduction).

d) Characteristics of the test medium.

5.1.2 Any special requirements, such as the position and orientation of the item in the chamber or bath, that may affect the reproducibility of the test, should be specified in the relevant specification.

*Basic environmental testing procedures for electronic and electrical items: Part XIV Change of temperature.

5.2 Influence by Object Under Test — The change of temperature test results are influenced by the differences between test objects with respect to the following parameters:

a) Heat capacity;

b) The amount of heat transfer to, and its distribution over, the item surface;

c) Heat conductivity inside the item, which may be non-homogeneous;

d) Thermal expansion of components and materials constituting the item;

e) Mechanical properties (for example, elasticity and tensile strength of components and material constituting the item);

f) Dimensions and tolerances; and

g) Other properties influencing the temperature distribution within the item.

5.3 This information may be used as a guide for the choice of the number of items and for the understanding of differences in test results.

6. GUIDANCE FOR THE SELECTION OF THE KIND OF TEST

6.1 Specifying a change of temperature test should be a matter of extreme care. Its successful application depends on a fundamental knowledge of the items to be tested, their technical properties and performance and the failure mechanism involved under conditions of rapidly changing temperature.

6.2 The severity of the test increases with:

a) greater temperature differences,

b) faster rates of change of temperature, and

c) more rapid heat transfer mechanisms.

The least severe test, commensurate with the amount of information required on item performance, should be specified.

6.3 The application of change of temperature tests as described in IS : 9000 (Part XIV)-1978* is preferred as part of a sequence of tests. Some types of damage may not become apparent by the final measurements of a change of temperature tests as described in IS : 9000 (Part XIV)-1978*, but may appear only during subsequent tests [for example, vibration (sinusoidal) or damp heat (cyclic)].

*Basic environmental testing procedures for electronic and electrical items: Part XIV Change of temperature.

6.4 The change of temperature test as described in Section 3 of IS : 9000 (Part XIV)-1978* should not be used as an alternative to sealing test.

6.5 The conditioning times should, whenever possible, be specified in such a way as to match the daily working time or 24 hours by an integral number of cycles, taking care of recovery and final measurements. If, for certain reasons, such as to avoid a change-over being made during the night, it is necessary to leave the item for a longer time than the prescribed duration t_1 in one of the exposure atmospheres, it should be left in the cold chamber because ageing effects may occur after a longer exposure to the warm atmosphere.

6.6 When specifying a change of temperature test, the properties of the objects under test which are affected by conditions of changing temperature, and their possible failure mechanism, should be kept in mind. The initial and the final measurements should be specified accordingly. In some cases, it may be sufficient to consider mechanical damage only. Measurements during the changing of temperature should be given primary consideration especially with equipments to be tested.

*Basic environmental testing procedures for electronic and electrical items: Part XIV Change of temperature.